

Spatial Analysis of Noise Exposure from Commercial Music Shops in Jos South LGA

¹Vincent Dung Choji, ¹Dapan Amen Jonah, ¹Buhari Hassan Arin, ²Ayodeji.P. Ifegbesan, ³Ibrahim Dinju Choji

¹Department of Geography, Plateau State University, Bokkos, Nigeria

²Department of Arts and Social Sciences Education, Olabisi Onabanjo University, Ago-Iwoye, Nigeria

³National Institute for Policy and Strategic Studies, Kuru, Plateau State, Nigeria

Corresponding author's email: pololis2005@gmail.com

DOI: <https://doi.org/10.5281/zenodo.20480096>

ABSTRACT

Environmental noise pollution is an increasing public health concern in urban environments. This study assessed the spatial distribution of noise exposure from music shops in Jos South Local Government Area, Nigeria, and examined its public health implications. Data were collected from 120 respondents using questionnaires and field-based sound level measurements at 15 music shop locations across five distance intervals (0–20 m). Noise measurements were obtained during morning, afternoon, and evening periods over two consecutive weekdays. Descriptive statistics, GIS-based analyses, Inverse Distance Weighting (IDW) interpolation, second-order trend surface modelling, residual analysis, and linear regression were used in the analyses. Results revealed extremely high noise levels at source points (mean = 109.13 dB), decreasing with distance but remaining above the recommended 55 dB limit at 20 m. IDW interpolation showed substantial spatial variability (104.8–113.2 dB), with pronounced noise hotspots in areas characterized by dense clusters of music shops. Trend surface analysis identified a broad spatial gradient in noise distribution, while residual mapping revealed localized hotspots and quieter zones associated with site-specific anthropogenic activities. Regression analysis demonstrated a strong inverse relationship between distance and noise intensity ($R^2 = 0.975$). Respondents reported disruption of communication, reduced concentration, and interference with daily activities, whereas awareness of noise regulations was generally low. The study concludes that music shops are major contributors to urban noise pollution and pose significant public health risks. It recommends stricter enforcement of noise regulations, increased public awareness, and the integration of noise control measures into urban planning and environmental management strategies.

Keywords: *Environmental Noise, Urban Noise Pollution, Noise Risk Zonation, Music Shops, Jos South LGA*

INTRODUCTION

Environmental noise pollution is a significant and growing public health challenge globally, driven by traffic, industrial activity, and commercial and recreational sound sources (World Health Organization. World Health Organisation [WHO], 2024); Münzel, Peris, & Sørensen, 2026). Chronic exposure to noise levels above recommended thresholds has been linked to sleep disturbance, cardiovascular

disorders, cognitive impairment, stress, and reduced quality of life (World Health Organisation [WHO], 2024; European Environment Agency, 2025; Baloye & Palamuleni, 2015). In the European Union, over 20 % of the population is exposed to harmful environmental noise, contributing to measurable health burdens and loss of healthy life years (European Environment Agency, 2025). Noise exposure above 55 dB during the day is

considered harmful, increasing the risk of physiological and psychological stress (WHO, 2024). The WHO 55 dB daytime guideline remains the primary benchmark for assessing environmental noise and health risks, including in Nigerian urban contexts (Olorunfoba et al., 2012; Oroke et al., 2020).

In Africa and Sub-Saharan Africa, rapid urbanization, population growth, and informal commercial activities have intensified noise exposure in cities. Urban sound measurements frequently exceed safe limits, with daytime noise in mixed-use areas often ranging from 75–90 dB, leading to sleep disruption, communication difficulties, and stress-related illnesses (Baloye & Palamuleni, 2015; Byaello, 2023; United Nations Environment Programme [UNEP], 2024). Despite the increasing burden of environmental noise pollution in rapidly urbanizing cities of sub-Saharan Africa, there remains a significant lack of spatially explicit noise mapping and predictive modelling frameworks. This data gap limits the ability of policymakers and urban planners to design effective mitigation and public health interventions (Clark et al., 2025; Elisha et al., 2025; Sylla et al., 2025).

In Nigeria, environmental noise is a growing concern in urban centres experiencing rapid urbanization. Empirical studies in towns such as Lagos, Minna, Osogbo, and Ado Ekiti report daytime noise levels above 80 dB, with residents regularly exposed to sound intensities that surpass WHO safe limits. These exposures have been associated with sleep disturbance, headaches, elevated stress, reduced concentration, and lower quality of life (Thompson et al., 2025; Elisha & Moses, 2024; Akande & Yusuf, 2021). Commercial and entertainment venues, including music shops and bars, contribute significantly to urban noise burdens, particularly where residential and commercial activities co-exist. (Olusoji, 2020; Münzel et al., 2026).

Noise exposure in Nigerian towns has both auditory and non-auditory health impacts, including temporary or permanent hearing impairment, cardiovascular stress, and cognitive challenges (WHO, 2024; European Environment Agency, 2025). Levels exceeding 85 dB, commonly recorded near commercial sources, are considered hazardous for prolonged exposure, leading to measurable increases in stress hormones and blood pressure among adults (WHO, 2024). Despite evidence of these impacts, most studies in Nigeria are limited to point measurements, lacking spatial analysis or predictive modelling to identify high-risk zones and assess exposure gradients (Agbo, 2020; Okeagu, Igwe, & Obiakor, 2025).

The literature on commercial leisure noise, particularly from music shops and similar establishments, remains limited in spatially explicit studies within urban Nigerian contexts. These outlets often generate high-intensity amplified sound that extends beyond their immediate premises into surrounding residential environments. The absence of detailed spatial analyses constrains a comprehensive understanding of exposure gradients and population-level risk distribution. This gap underscores the need for more localized, spatially resolved investigations to support evidence-based urban planning, effective noise mitigation strategies, and improved regulatory enforcement. To address these gaps, the present study applies spatial analysis and statistical modelling to quantify environmental noise exposure from commercial music sources in urban Nigerian towns. The study examines sound levels at multiple distances from sources, generates risk zonation maps, and evaluates the relationship between noise intensity and distance from source points.

Accordingly, the study tests the hypothesis that there is no significant relationship between distance from commercial music sources and environmental noise levels in Jos-South L.G.A, Plateau State.

MATERIALS AND METHODS

Study Area

The study was conducted in Jos South Local Government Area (LGA), Plateau State, Nigeria, selected for its high concentration of music shops and commercial activities, which make it a hotspot for environmental noise pollution. Located on the Jos Plateau, the area is a center for tourism, industry, and commerce, lying between latitudes 9°34'22"–9°54'40" N and longitudes 8°39'55"–8°59'13" E, at an average altitude of approximately 1,280 m and covering 1,037 km² (Bala et al., 2021). It shares borders with Jos North, Jos East, Barkin Ladi, Riyom, and Bassa LGAs and comprises key districts such as Vwang, Kuru, Gyel, Zawan, and Du, which feature a mix of urban and rural settlements supporting agriculture, infrastructure, and economic development. Since its creation, the population has grown from about 311,392 in 2006 to 439,946 in 2023 (National Population Commission of Nigeria (NPC, 2023), driven by urbanization and economic expansion. The population is predominantly Berom, known for hospitality and industriousness, alongside other ethnic groups attracted by historical tin mining, business opportunities, and proximity to Jos Township, fostering a diverse and integrated community.

Sampling Design

A structured spatial sampling design was employed to ensure balanced representation across locations and distances. Fifteen music shop locations were selected, and at each location, five distance intervals (0 m, 5 m, 10 m, 15 m, and 20 m) were considered, with two respondents surveyed per distance, per location, yielding a total of 120 respondents. This sampling design was chosen because it allows for spatially explicit measurement of noise exposure and perception relative to proximity to sources, ensuring that the resulting data accurately reflect variations in exposure and the associated human impacts.

Data Collection Methods

A structured questionnaire was administered to capture respondents' socio-demographic characteristics, duration of residence or work near music shops, frequency and perception of loud music, reported effects on daily life, and awareness of noise regulations. This method was selected because it enables the collection of subjective human experiences of noise, which are critical for understanding the social, cognitive, and health impacts of environmental noise and complement the objective measurements. Environmental noise measurements were conducted using a calibrated digital sound level meter at distances of 0, 5, 10, 15, and 20 m from each music shop. Measurements were obtained over two consecutive weekdays during peak activity periods: morning (7:00–8:00 am), afternoon (12:00–1:00 pm), and evening (5:00–6:00 pm). At each sampling point, two readings were recorded at 15-minute intervals and averaged to derive representative exposure levels. This approach provided standardized and reliable data for assessing spatial variations in noise intensity and comparison with WHO environmental noise guidelines. Descriptive statistics were calculated, including the mean, standard deviation, and variance, to summarize noise intensity and exposure patterns across different distances and locations. Additionally, noise risk zonation maps were generated using GIS software to visualize areas of high, moderate, and slight risk based on measured sound levels. These analyses were included to identify spatial patterns of noise exposure, which are essential for urban planning, risk assessment, and the prioritization of mitigation interventions. Simple linear regression was used to assess the relationship between noise levels and distance from the source, with noise as the dependent variable and distance as the independent variable. The model also served as a predictive tool for estimating noise levels at unmeasured locations, enabling identification of high-risk

areas and supporting evidence-based planning for noise mitigation.

WHO Permissible Limits for Environmental Noise

Measured noise levels were evaluated against the World Health Organization (WHO) guideline of 55 dB (LAeq) for outdoor residential areas during daytime periods (WHO, 2018; WHO, 2024). This benchmark was applied to assess exposure at 0–20 m distances, enabling classification of noise levels relative to internationally accepted safety thresholds and identification of areas exceeding permissible limits for public health risk interpretation.

Noise Risk Zonation Map Production

Noise risk mapping was conducted using field measurements obtained from 15 music shop locations in Jos South Local Government Area. Sound levels were recorded at 0–20 m intervals using a sound level meter, and mean noise values were computed for each site. Geographic coordinates collected with a GPS receiver were used to georeferenced sampling locations within a GIS environment. Inverse Distance Weighting (IDW) interpolation was applied to generate a continuous noise surface and visualize the spatial distribution of environmental noise. To further examine broad spatial patterns and local variations, a second-order trend surface analysis and residual mapping were performed. The trend

Socio-Demographic Characteristics of Respondents

The socio-demographic profile indicates that females (55.8%) slightly outnumbered males (44.2%). Respondents were predominantly within the economically active age group of 31–45 years (40.8%), followed by those aged 18–30 years (33.3%). Traders constituted the largest

surface model was used to identify regional trends in noise distribution, while residual analysis highlighted localized deviations from the predicted trend, revealing potential noise hotspots and quieter zones. The interpolated noise surface was subsequently classified into four risk zones based on World Health Organization (WHO) standards: safe (<55 dB), moderate (55–70 dB), high (70–85 dB), and extremely hazardous (>85 dB). The final maps were produced using graduated colour schemes to illustrate spatial variability, identify high-risk exposure areas, and support environmental planning and noise mitigation strategies.

RESULTS AND DISCUSSION

This section presents the survey findings, environmental noise measurements, and statistical analyses conducted in Jos South Local Government Area. It covers respondents' socio-demographic characteristics and perceptions of noise exposure, measured sound levels at varying distances from music shop sources, spatial patterns of noise attenuation, and risk classification based on World Health Organization (WHO) guidelines. The section also includes GIS-based noise risk zonation, comparative analysis with the 55 dB outdoor residential threshold, and regression analysis examining the relationship between noise level and distance from the source.3.1.1 Socio-Demographic, Exposure, and Noise Profile of Respondents.

occupational category (38.3%), while most respondents had resided in the area for more than six years (41.7%), suggesting a relatively stable population with substantial knowledge of local environmental conditions. Results are presented in Table 1

Table 1: Socio-Demographic Characteristics of Respondents (n = 120)

Variable	Category	Frequency	Percentage (%)
Gender	Male	53	44.2
	Female	67	55.8
Age	Under 18	3	2.5
	18–30	40	33.3
	31–45	49	40.8
	46–60	22	18.3
	Above 60	6	5.0
Occupation	Trader	46	38.3
	Student	36	30.0
	Civil Servant	22	18.3
	Artisan	6	5.0
	Others	10	8.4
Duration in Area	<1 year	10	8.3
	1–3 years	36	30.0
	4–6 years	24	20.0
	>6 years	50	41.7

Source: Authors' Analyses

With Table 2, the results indicate high levels of exposure to commercial music-related noise. Most respondents (81.7%) lived or worked near music shops, while 75.8% reported daily exposure to loud music. Noise was perceived to

be highest during the afternoon period (45.0%). Furthermore, more than four-fifths of respondents rated the noise level as either high (51.7%) or very high (30.0%), suggesting that excessive noise is a persistent environmental issue within the study area.

Table 2: Noise Exposure and Spatial Characteristics of Respondents (n = 120)

Variable	Category	Frequency	Percentage (%)
Near Music Shop	Yes	98	81.7
	No	22	18.3
Exposure Frequency	Daily	91	75.8
	Few times/week	10	8.3
	Occasionally	19	15.9
Time Loudest	Morning	32	26.7
	Afternoon	54	45.0
	Evening	24	20.0
	Late Night	10	8.3
Loudness Rating	Very Low	3	2.5
	Low	4	3.3
	Moderate	15	12.5
	High	62	51.7
	Very High	36	30.0

Source: Authors' Analyses

Table 3: Perceived Effects of Music-Related Noise Exposure (n = 120)

Variable	Category	Frequency	Percentage (%)
Music Affects Activities	Yes	86	71.7
	No	34	28.3
Reported Effects	Sleep Disturbance	10	8.3
	Lack of Concentration	28	23.3
	Headaches	12	10.0
	Difficulty in Communication	30	25.0
	Others/No Effect	40	33.4
Reported Effects	Sleep Disturbance	10	8.3
	No	96	80.0

Source: Authors' Analyses

In Table 3, a substantial majority of respondents (71.7%) reported that loud music negatively affected their daily activities. The most common impacts were difficulty in communication (25.0%) and lack of concentration (23.3%),

followed by headaches (10.0%) and sleep disturbance (8.3%). These findings indicate that music-related noise has noticeable social and health implications for residents and business operators within the study area.

Table 4: Awareness, Reporting, and Mitigation Measures (n = 120)

Variable	Category	Frequency	Percentage (%)
Considered Noise Pollution	Yes	82	68.3
	No	8	6.7
	Not Sure	30	25.0
Complained/Reported	Yes	66	55.0
	No	54	45.0
Complaint Recipient	Shop Owner	41	34.2
	Local Authority	9	7.5
	Police	3	2.5
	Community Leader	7	5.8
	Did Not Report	60	50.0
Awareness of Regulations	Yes	24	20.0
	No	96	80.0
Suggested Measures	Government Intervention	62	51.7
	Owner Awareness	58	48.3

Source: Authors' Analyses

Table 4 revealed that most respondents (68.3%) perceived music shop noise as a form of noise pollution. Although 55.0% reported making complaints, reporting was primarily directed to shop owners rather than formal authorities. Regulatory awareness was generally low, with only 20.0% of respondents aware of existing noise-control regulations. Respondents identified government intervention (51.7%) and increased awareness among shop owners

(48.3%) as the most effective strategies for reducing noise pollution in the area.

Sound Level Measurements Around Music Shops

Environmental noise measurements were conducted at selected music shop locations in Jos South L.G.A using a digital sound level meter. Sound intensity levels were recorded at five distance intervals from each music shop source in order to examine the spatial pattern of noise attenuation. The results are presented in Table 5.

Table 5: Noise Level Measurements (dB) at Different Distances from Selected DJ Locations in Jos Metropolis.

S/N	Location	0 m	5 m	10 m	15 m	20 m
1	ELSHEEZY ZAWAN	110.0	92.7	79.2	63.4	68.4
2	DJ FLASH ZAWAN	108.0	95.6	75.6	64.0	57.7
3	DJ BITE ZAWAN JUNCTION	107.0	92.9	79.1	62.1	57.8
4	DJ MAKATA VOM	109.0	96.5	78.9	61.8	57.8
5	DJ FLEXX VOM JUNCTION	112.0	101.0	61.1	55.0	51.2
6	DJ JANGO DJ JUNCTION	112.0	101.0	76.4	61.1	58.3
7	DJ STAVOU AD KASUWA VOM	109.0	96.9	77.5	60.9	61.2
8	DJ HOMES VWANG	107.0	91.1	79.6	64.7	56.2
9	DJ HUMZY OPPOSITE MARET	107.0	92.4	78.3	61.9	55.9
10	DJ MATT TRADE CENTER	108.0	95.3	75.6	61.4	55.3
11	DJ XKIMO GYEL JUNCTION	111.0	95.6	89.3	70.5	59.2
12	DJ ALVIN GYEL JUNCTION	115.0	106.0	84.4	76.4	65.3
13	DJ JENG JAGO GYEL	105.0	87.6	87.6	60.8	53.3
14	DJ CLINTON BUKURU	108.0	94.4	78.1	61.5	58.2
15	DJ BENNIGY RAYFIELD	109.0	95.0	75.4	63.3	59.2

Source: Authors' Analyses

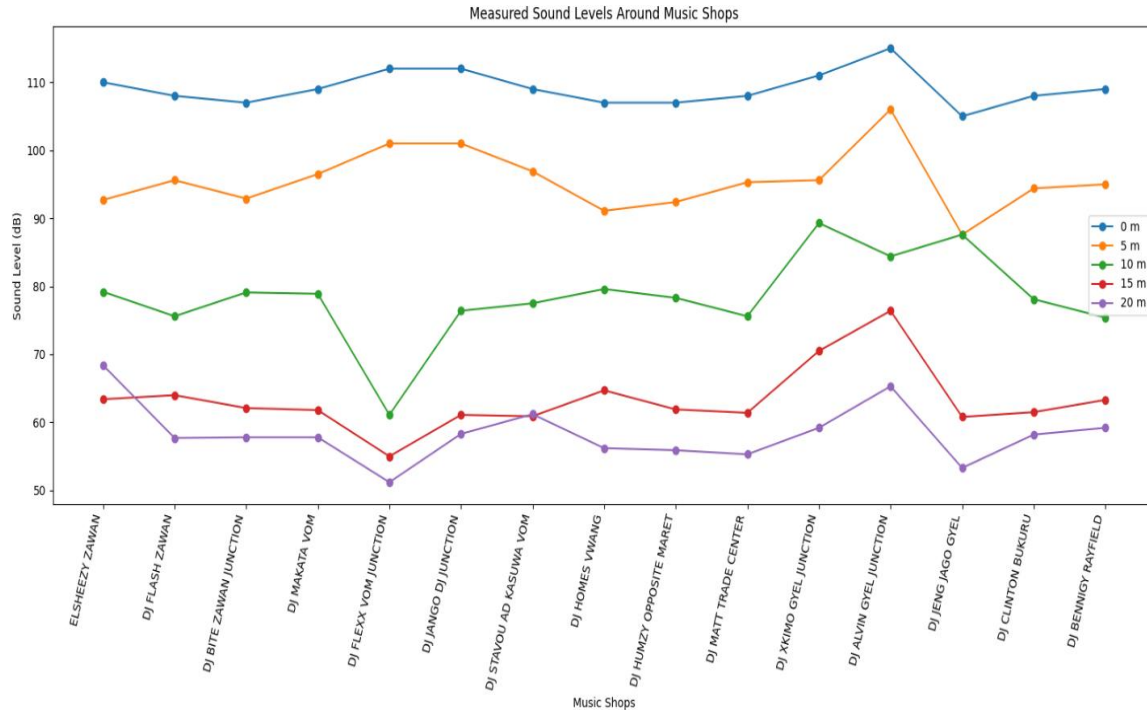


Figure 1: Spatial Variation of Environmental Noise Levels Around Music Shops in Jos South LGA
 Source: Authors' Analyses

The graph (Figure 1) shows a clear distance–decay pattern in noise levels around music shops in Jos South LGA. Extremely high levels at the source ($\approx 105\text{--}112$ dB) decline gradually with distance: 5 m ($\approx 90\text{--}106$ dB), 10 m ($\approx 60\text{--}90$ dB), and 15 m ($\approx 55\text{--}80$ dB). At 20 m, levels reduce further to $\approx 51\text{--}68$ dB, though some sites still approach/exceed WHO limits (55 dB). Overall, noise attenuates with distance but remains above safe thresholds in several locations, indicating sustained exposure risk.

Measured Noise Levels and Descriptive Statistics

Table 6 and Figure 2 present the descriptive statistics and spatial variation of measured sound

intensity levels at different distances from the music shop sources. The results show that the mean noise level at 0 m was 109.13 dB, with a standard deviation of 2.69 and a variance of 7.24. At 5 m, the mean sound level decreased to 95.60 dB (SD = 4.35; Var = 18.92). At 10 m, the mean noise level was 78.41 dB with a standard deviation of 7.41 and a variance of 54.89. At 15 m, the recorded mean was 63.25 dB (SD = 4.85; Var = 23.52), while at 20 m the mean value further decreased to 58.33 dB with a standard deviation of 4.20 and a variance of 17.64. Figure 2 provides a graphical representation of these measurements, illustrating the pattern of sound level decay as the distance from the music shop sources increases.

Table 6: Descriptive Statistics of Noise Levels at Different Distances

Distance	Mean Noise (dB)	Risk Level
0 m	109.13	Extremely hazardous
5 m	95.60	Very high risk
10 m	78.41	High risk
15 m	63.25	Moderate risk
20 m	58.33	Slight risk

Source: Authors' Analyses

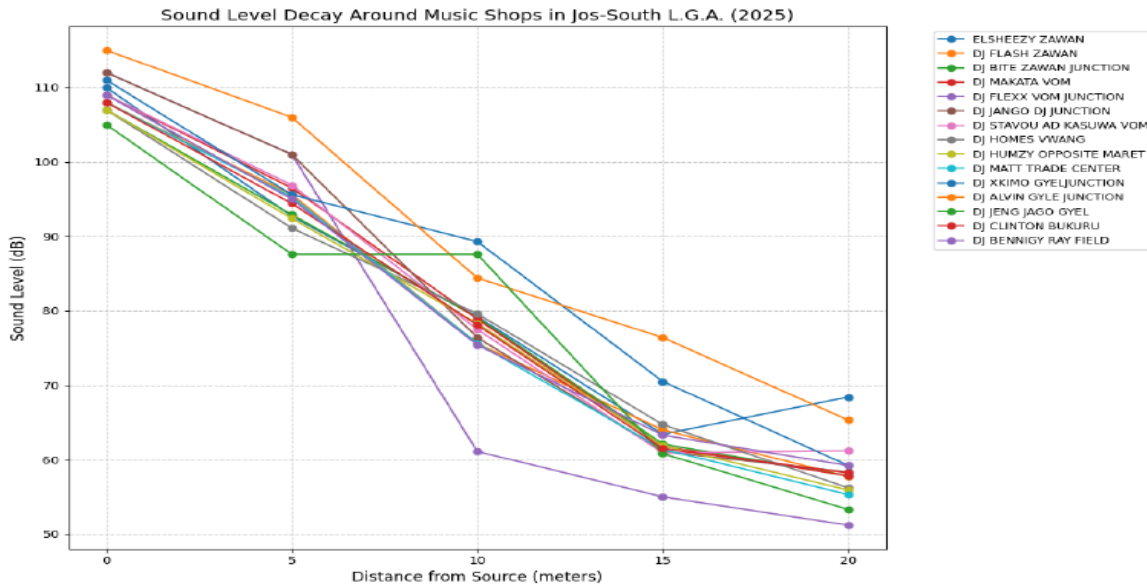


Figure 2: Sound Level Decay Around Music Shops in Jos South

Source: Authors’ Analyses

Noise Risk Zonation Matrix

Table 7 and Figure 3 show the classification and spatial distribution of environmental noise risk from music shops in Jos South Local Government Area based on mean sound levels across distance intervals. Noise levels demonstrate a clear attenuation pattern with distance: 109.13 dB (0 m, extremely hazardous), 95.60 dB (5 m, very high risk), 78.41 dB (10 m, high risk), 63.25 dB (15 m, moderate risk), and 58.33 dB (20 m, slight risk). The Noise Risk

Zonation Map indicates that Gyel and Zawan fall within extremely hazardous zones, Vom and Bukuru within high-risk zones, while peripheral areas such as Rayfield show moderate to safe exposure levels, confirming spatial decline in noise intensity away from music shop clusters. Although Table 3 presents point measurements, spatial distribution was modelled using Inverse Distance Weighting (IDW) interpolation in a GIS environment to generate a continuous noise surface for Figure 3, enabling clear visualization of exposure gradients and risk zones.

Table 7: Distance from Source Mean Noise Level (dB) Risk Classification

Distance	Mean Noise (dB)	Risk Level
0 m	109.13	Extremely hazardous
5 m	95.60	Very high risk
10 m	78.41	High risk
15 m	63.25	Moderate risk
20 m	58.33	Slight risk

Source: Authors’ Analyses

Spatial Modelling of Environmental Noise Using IDW Interpolation and Residual Trend Analysis

Figure 3 illustrates the spatial distribution of environmental noise levels generated using the

Inverse Distance Weighting (IDW) interpolation method. Noise levels range from approximately

104.8 dB to 113.2 dB, indicating substantial spatial variation across the study area. Higher noise levels are concentrated in the central-eastern section, where clusters of music shops form distinct noise hotspots exceeding 112 dB. In contrast, lower noise levels are observed in the western and southwestern areas where music

shops are less concentrated. The spatial pattern demonstrates that noise intensity decreases with increasing distance from major noise sources, highlighting the significant influence of music shop clustering on environmental noise distribution within the study area.

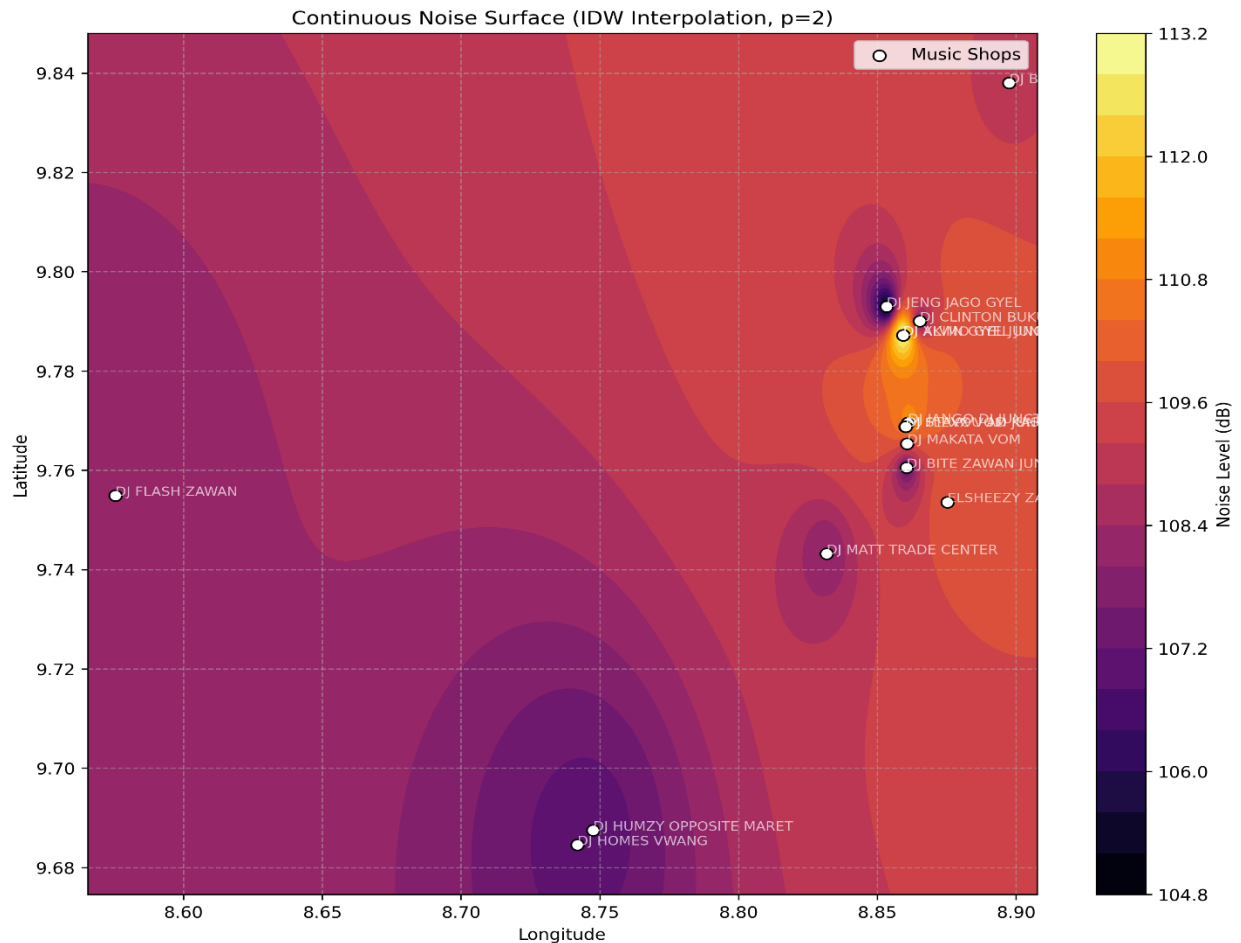


Figure 3. Spatial Distribution of Environmental Noise Levels Based on IDW Interpolation ($p = 2$)

Source: Authors' Analyses

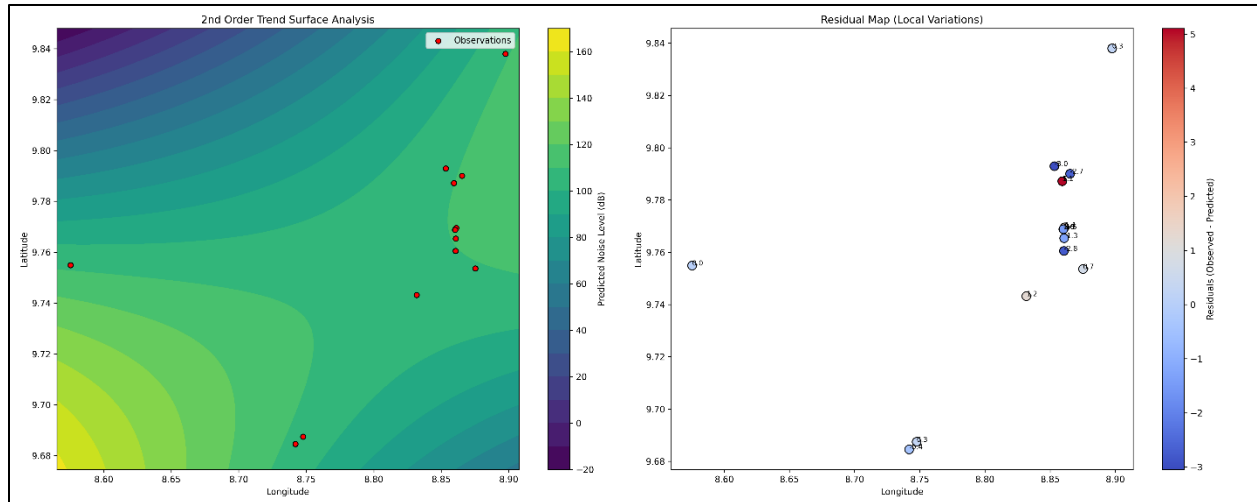


Figure 4. Spatial Trend Surface and Residual Maps of Measured Noise Levels

Left Panel: Second-Order Trend Surface Analysis

Source: Authors' Analyses

The left panel of Figure 4 presents the second-order trend surface analysis of noise levels in the study area. Predicted noise levels generally increase toward the southwestern section and decrease toward the northwestern section, indicating a broad spatial gradient in noise distribution. The smooth contour pattern suggests that large-scale geographical and anthropogenic factors influence noise levels across the area. The model is termed second-order because it incorporates quadratic terms, enabling the representation of curved spatial trends rather than a simple linear surface.

The right panel of Figure 4 shows the residual map, representing the differences between observed and predicted noise levels after removing the regional trend. Most locations exhibit small residual values, indicating that the trend surface adequately captures the overall spatial pattern of noise. However, some positive and negative residuals reveal localized noise hotspots and quieter zones, suggesting that site-specific factors such as traffic, commercial activities, and music shops contribute to noise variations beyond the broad spatial trend.

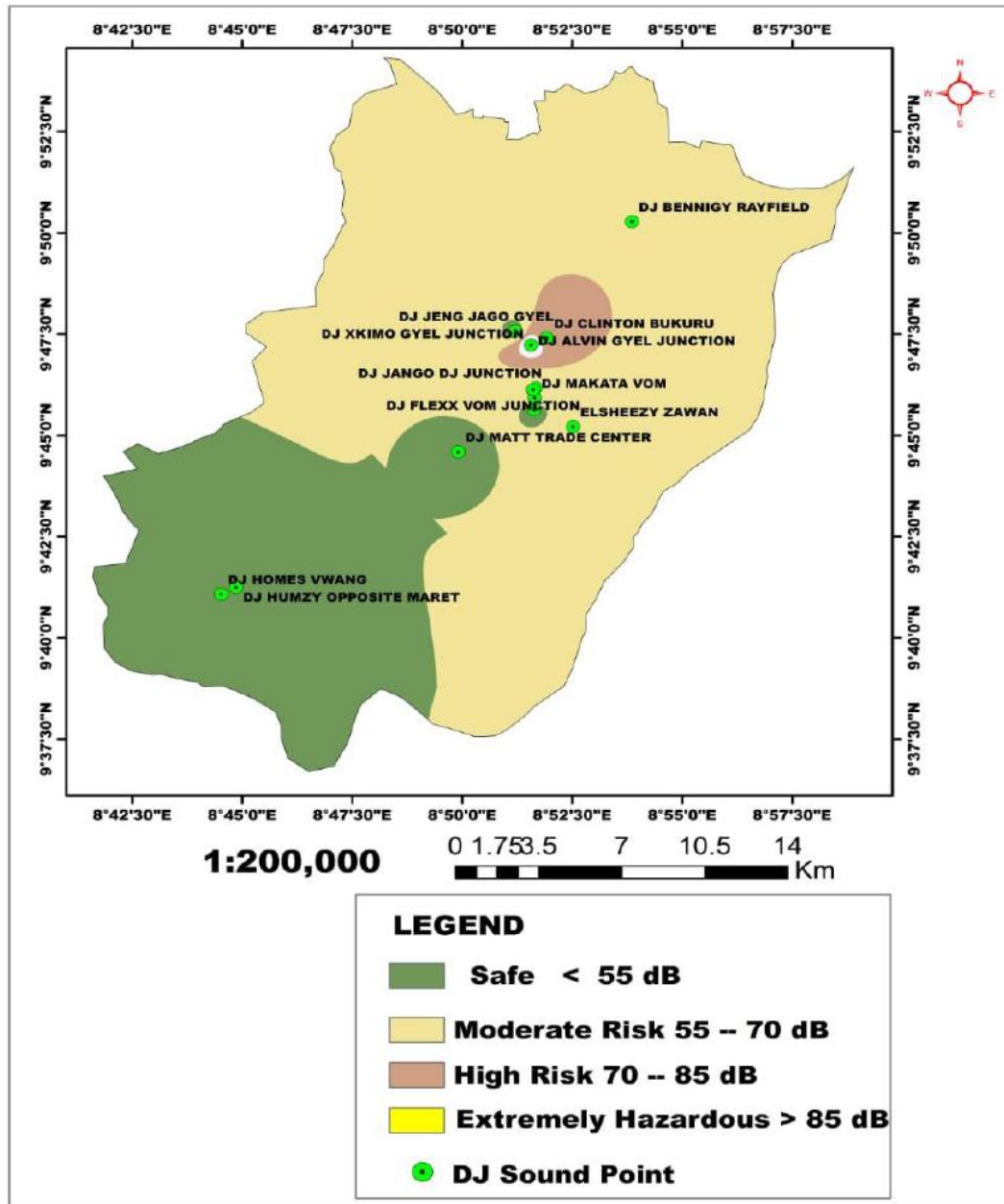


Figure 5: Noise Risk Zonation Map of Jos South.
 Source: Authors' Analyses

Illustrates the spatial distribution of extremely hazardous, very high, moderate, and slight risk zones around music shops.

Spatial Noise Decay Plot and WHO Limits

Figure 5 presents the spatial decay pattern of measured sound intensity levels at increasing distances from the music shop sources. The plot

displays the mean noise levels recorded at 0 m, 5 m, 10 m, 15 m, and 20 m, with error bars representing the standard deviation of the measurements. The figure also includes a yellow dotted horizontal line representing the recommended environmental noise guideline value of 55 dB for outdoor residential areas, established by the World Health Organization.

This reference line provides a benchmark for assessing the measured sound levels relative to acceptable environmental noise exposure limits for residential environments. According to the WHO community noise guidelines, outdoor

sound levels around dwellings should generally not exceed approximately 55 dB LAeq during daytime periods to prevent serious annoyance and disturbance to residents.

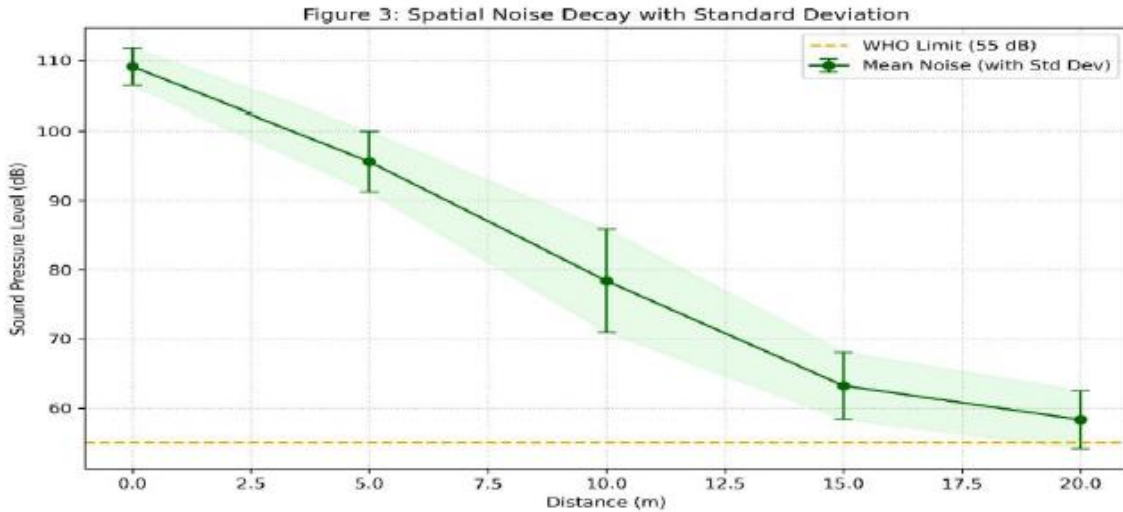


Figure 6: Spatial Noise Decay Plot with Error Bars and WHO Limit
 Source: Authors' Analyses

Relationship between sound intensity levels and distance from the music shop sources

Table 8, Table 9, and Figure 7 present the regression analysis examining the relationship between sound intensity levels and distance from the music shop sources. The regression model is expressed as Noise Level = 107.73 - 2.68 (Distance). The regression statistics (Table 4) show an intercept of 107.73 and a slope of -2.68, indicating a decrease in sound intensity with

increasing distance from the source. The coefficient of determination ($R^2 = 0.975$) indicates a strong relationship between the variables, while the p-value (0.0017) indicates statistical significance. Table 5 compares the observed and predicted noise levels across the distance intervals, while Figure 4 illustrates the linear regression relationship between sound intensity and distance.

Table 8: Relationship between sound intensity levels and distance from the music shop sources

Statistic	Value
Intercept	107.73
Slope	-2.68
R^2	0.975
p-value	0.0017

Source: Authors' Analyses

Table 9: Observed and Predicted Noise Levels

Distance (m)	Observed (dB)	Predicted (dB)
0	109.13	107.73
5	95.60	94.34
10	78.41	80.95
15	63.25	67.55
20	58.33	54.16

Source: Authors' Analyses

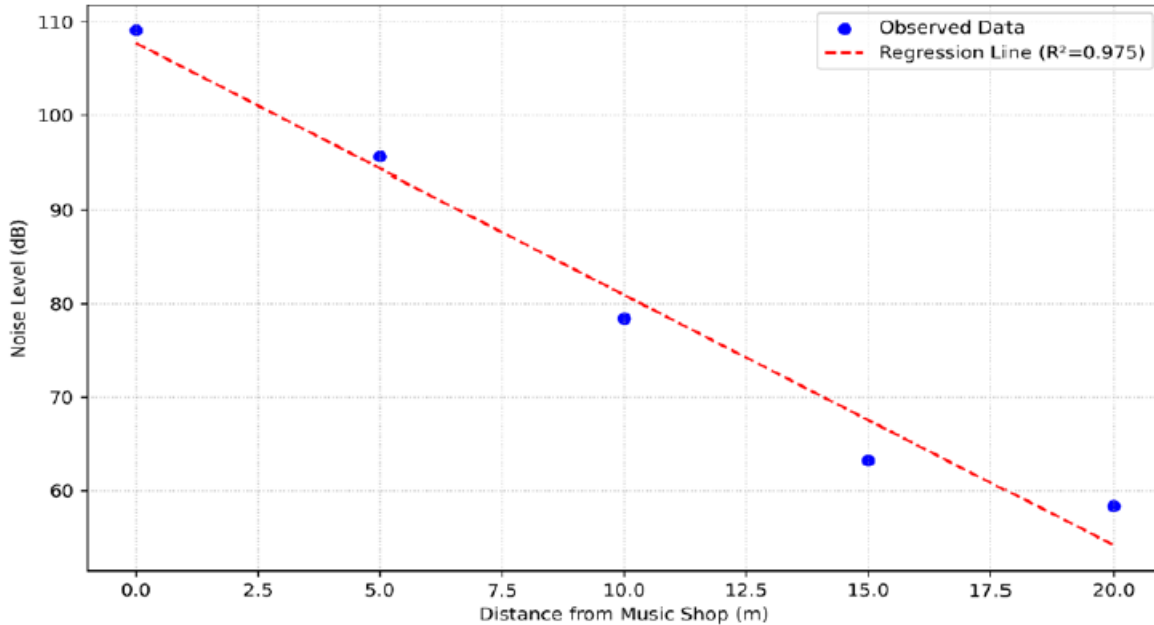


Figure 7: Linear Regression Plot of Noise Level vs Distance

Source: Authors' Analyses

DISCUSSION

A survey of 120 respondents around music shops showed that most were young and middle-aged adults (18–45 years) who live or work nearby (Baloye & Palamuleni, 2015). Daily exposure to loud music was reported by 75.8%, especially in the afternoon, disrupting communication, concentration, and routine activities (Alani et al., 2020; Byaello, 2023; see Table 1; Figure 2). These findings indicate that noise is persistent and intrusive, affecting economically and socially active individuals. The results underscore the need for zoning, buffer zones, and urban noise management, particularly in mixed-use areas, to protect public health and quality of life

Awareness of government noise regulations was low (20%), highlighting a substantial gap in knowledge and the need for policy enforcement and public education (Ohaeri & Obafemi, 2024). Socio-demographic findings emphasize that noise pollution is not merely a physical phenomenon but a public health concern with social and economic implications, affecting residents' daily activities and quality of life (Akanke & Yusuf, 2021). These results indicate that low awareness of regulations contributes to persistent noise exposure, reinforcing the need for targeted interventions, education campaigns, and stricter enforcement, particularly in urban areas with high residential and commercial interaction.

Environmental measurements confirmed extremely high sound intensity at source points, with a mean of 109.13 dB at 0 m, decreasing to 58.33 dB at 20 m (Table 2; Figure 2), demonstrating the distance-decay effect where noise intensity decreases with distance from the source (World Health Organization, 2018). Levels near the source greatly exceed 85 dB, the threshold for safe prolonged exposure, indicating serious risks for auditory effects (hearing loss, tinnitus) and non-auditory effects such as stress, sleep disturbances, and headaches (World Health Organization, 2018; Biddle, 2025). This pattern is consistent with other Nigerian urban noise studies, where commercial areas report persistently high noise exposure. For example, in Onitsha, daytime noise in major commercial districts consistently exceeded 84 dB, reflecting prolonged exposure in densely populated commercial zones (Okeagu et al., 2025). Similarly, Port Harcourt shows that high ambient noise from commerce and traffic negatively affects residents' health and quality of life (Eze & Horsfall, 2025)

Descriptive statistics and the noise risk zonation matrix show that extremely hazardous and very high-risk zones are concentrated within 0–5 m of music shops, with moderate and slight risk zones extending to 20 m (Table 3; Figure 3). This is significant because it identifies areas where intervention is most critical and where residents face the greatest health risks (World Health Organization, 2018). Similar spatial patterns are observed in South-South Nigeria, where industrial and commercial noise frequently exceeds acceptable limits, impacting health, social life, and economic activities (Ohaeri & Obafemi, 2024). Noise mapping and zonation are practical tools for urban planners, guiding buffer zones, noise barriers, and enforcement measures to protect vulnerable populations (Akande & Yusuf, 2021).

Comparison with WHO recommended limits for outdoor residential areas (~55 dB LAeq) revealed that most measured levels exceed safe thresholds, particularly within 15 m of music

shops (Figure 4). Exceedances above these limits are associated with adverse health outcomes, including cardiovascular stress, sleep disturbance, and reduced cognitive performance (World Health Organization, 2018). Globally, studies in Europe and other urban centres show similar exceedances in commercial, traffic, and recreational zones, highlighting that urban noise is a universal environmental health issue (European Environment Agency, 2025).

The geospatial analyses provided further evidence of the spatial heterogeneity of environmental noise within the study area. The IDW interpolation map (Figure 3) revealed distinct noise hotspots, with noise levels ranging from 104.8 dB to 113.2 dB and the highest intensities concentrated in areas with dense clusters of music shops. The observed decline in noise levels away from these clusters confirms the localized nature of commercial noise pollution and highlights the influence of music shop concentration on environmental noise exposure. Similar studies have demonstrated the usefulness of IDW interpolation in identifying noise hotspots and supporting urban noise management (Wickramathilaka et al., 2023).

The second-order trend surface analysis (Figure 4, left panel) identified a broad spatial gradient in noise distribution, indicating that large-scale anthropogenic and land-use factors contribute to environmental noise patterns. Because the model incorporates quadratic terms, it effectively captures curved spatial trends and provides a more realistic representation of noise variability than simple linear models (Meller et al., 2023). The residual analysis (Figure 4, right panel) showed generally small residual values, suggesting good model performance, while localized positive and negative residuals revealed noise hotspots and quieter zones associated with site-specific factors such as traffic intensity and commercial activities. These findings demonstrate the value of combining interpolation, trend surface modelling, and residual analysis to identify priority areas for

noise mitigation and urban planning interventions (Gharehchahi et al., 2024).

The regression model (Noise Level = $107.73 - 2.68 \times \text{Distance}$; $R^2 = 0.975$) shows that distance strongly predicts noise reduction. Practically, it provides a simple tool for estimating noise at unmeasured points, enabling the delineation of buffer zones around music shops, identification of at-risk residential areas, and support for setback regulations. It can also guide noise mapping and targeted mitigation where monitoring equipment is limited.

CONCLUSION AND RECOMMENDATION

The integrated socio-demographic, field measurements, noise risk zonation, and regression analyses show that loud music from shops in Jos South LGA constitutes a significant environmental and public health concern. Noise levels at all measured distances (0–20 m) exceeded the recommended World bank 55 dB and NESREA 75 dB limit for residential areas, indicating widespread unsafe exposure. Although a clear distance-decay pattern was observed, noise levels remained above safe thresholds even at 20 m. The study concludes that music shops generate excessively high noise levels that significantly disrupt communication, concentration, and daily activities among residents and workers, particularly young and middle-aged individuals. These effects contribute to reduced productivity, increased stress, and lower quality of life. The findings align with local and global studies, confirming that urban leisure-related noise is a persistent public health issue. To mitigate these impacts, stronger enforcement of noise regulations and clear permissible limits are required, alongside regular monitoring. Public awareness campaigns should educate stakeholders on the health risks of excessive noise and promote responsible practices. Urban planning measures—such as zoning, buffer zones, and noise barriers should be implemented to reduce exposure. In addition,

music shop operators should adopt sound control measures like soundproofing and proper speaker orientation, while residents should be empowered to report violations. In sum, effective noise reduction in Jos South requires coordinated regulatory action, public engagement, and sustainable urban planning to protect community health.

The geospatial analyses further demonstrated that environmental noise is not uniformly distributed across the study area. IDW interpolation identified distinct noise hotspots associated with clusters of music shops, while the second-order trend surface analysis revealed broader regional gradients in noise distribution. Residual trend analysis further highlighted localized noise anomalies that were not fully explained by the regional trend, indicating the influence of site-specific anthropogenic activities. These findings demonstrate the value of integrating spatial interpolation, trend surface modelling, and residual analysis in environmental noise assessment, as they provide critical information for identifying high-risk zones, prioritizing intervention areas, and supporting evidence-based urban planning and noise control policies.

References

- Agbo, C. O. A. (2020). Noise pollution in Nigeria's institutions of higher learning: A review. *Journal of Engineering Research and Reports*, 18(1), 8–21.
- Akande, O., & Yusuf, A. (2021). Residential noise exposure and quality of life in Nigerian urban environments. *Ethiopian Journal of Public Health and Environmental Studies*, 7(22), 455–467.
- Alani, R. A., Ogunmoyela, O. M., Okolie, C. J., & Daramola, O. E. (2020). Geospatial analysis of environmental noise levels in a residential area in Lagos, Nigeria. *Noise Mapping*, 1, 223–238. <https://doi.org/10.1515/noise-2020-0019>

- Bala, A., Garba, S., Adewuyi, T., & Youngu, T. (2021). Geospatial analyses of mining-induced land degradation sites in Jos South Local Government Area, Plateau State, Nigeria. FIG e-Working Week.
- Baloye, D. O., & Palamuleni, L. G. (2015). A comparative land use-based analysis of noise pollution levels in selected urban centers of Nigeria. *International Journal of Environmental Research and Public Health*, 12(10), 12225–12246. <https://www.mdpi.com/1660-4601/12/10/12225>
- Biddle, J. (2025, June 2). How noise pollution quietly affects your health. University of California, Davis, Center for Occupational and Environmental Health. <https://coeh.ucdavis.edu/research/how-noise-pollution-quietly-affects-your-health>
- Byaello, F. (2023). Noise pollution and well-being in Lagos metropolitan area: A community health perspective. *Journal of Urban Environmental Health*, 4(4), 203–215.
- Byaello, J. (2023). Urban noise perception and community impact in Nigeria. *Journal of Urban Health Studies*, 6(1), 33–48. <https://www.hdpublishation.com/article/203>
- Clark, S. N., Arku, R. E., Ezzati, M., Bennett, J., Nathvani, R., Alli, A. S., & Brauer, M. (2025). Moving beyond the noise: Geospatial modelling of urban sound environments in a sub-Saharan African city. *Scientific Reports*, 15(1), 21403.
- Elisha, O. K., & Moses, O. A. (2024). Noise pollution awareness and its health effects in Ado Ekiti market. *International Journal of Research in Arts and Social Sciences*, 9(02), 1–12.
- Elisha, O. A., Nyambane, O. S., & Francis, G. J. (2025). GIS-based spatial modelling of road traffic noise distribution in Nairobi City, Kenya. *Journal of Engineering Research and Reports*, 27(12), 275–293.
- Eze, A. C., & Horsfall, I. T. (2025). Assessment of noise pollution level in Port Harcourt City: A location-based comparative study. *International Journal of Environmental Noise and Pollution Control*, 3(2), 7–17.
- European Environment Agency. (2025). Environmental noise in Europe — 2025 report. <https://www.eea.europa.eu/en/analysis/publications/environmental-noise-in-europe-2025>
- European Environment Agency. (2025, June 24). Noise pollution harms health of millions across Europe, report finds. TheGuardian. <https://www.theguardian.com/environment/2025/jun/24/noise-pollution-harms-health-of-millions-across-europe-report-finds>
- Münzel, T., Peris, E., & Sørensen, M. (2026). From noise to heart disease: European Environment Agency sounds the alarm for Europe 2025.
- Okeagu, F. N., Igwe, K. C., & Obiakor, O. (2025). Assessment of noise pollution levels in Onitsha Metropolis: A case study of major districts. *International Journal of Industrial and Production Engineering*, 3(2), 1–13.
- Ohaeri, E. C., & Obafemi, A. A. (2024). Noise pollution status in South-South Nigeria. *Asian Journal of Geographical Research*, 7(1), 94–103.
- Oloruntoba, E. O., Ademola, R. A., Sridhar, M. K. C., Agbola, S. A., Omokhodion, F. O., Ana, G. R. E. E., & Alabi, R. T. (2012). Urban environmental noise pollution and perceived health effects in Ibadan, Nigeria.

African Journal of Biomedical Research, 15(2), 77–84.

Olusoji, S. (2020). A Critical Investigation on Housing and Musical Noise Pollution in Selected Neighborhoods in Lagos, Nigeria. *African Journal of Housing and Sustainable Development*, 1(1), pp. 3-12.

Oroke, A. M., Sarihan, E., Ogbuene, E. B., & Ani, C. (2020). Assessment of Noise Pollution Level in Abakaliki Metropolis, Ebonyi State Nigeria. *Theoretical and Empirical Researches in Urban Management*, 15(1), 75–83.

Sylla, G., Apparicio, P., Gelb, J., & Robin, O. (2025). Mapping road traffic noise descriptors in a sub-Saharan city: An extensive mobile data collection in Abidjan (Ivory Coast). *African Transport Studies*, 3, 100067.

National Population Commission. (2023). Population estimates and demographic profile of Jos South Local Government Area. NPC Jos State Office.

Thompson, A. A., Adepoju, O., & Nwosu, I. (2025). Impact of noise pollution on residents' health in Osogbo metropolis, Nigeria. *International Journal of Social Sciences and Humanities Invention*, 12(02), 1–9.

United Nations Environment Programme. (2024). Noise pollution — global environmental outlook. <https://www.unep.org/resources>

World Health Organization. (2018). Environmental noise guidelines for the European Region. WHO Regional Office for Europe. <https://iris.who.int/bitstream/handle/10665/279952/9789289053563-eng.pdf>

World Health Organization. (2024). Compendium of WHO and other UN

guidance on health and environment (Environmental noise). <https://www.who.int/tools/compendium-on-health-and-environment/environmental-noise/>

World Health Organization. (2024). Environmental noise guidelines for the European Region: Protecting people from noise. <https://www.who.int/europe/health-topics/noise>